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(71)Applicant : **SONY CORP**
(72)Inventor : **MIYATO YOSHIKAZU**
MOMOSHIRO TOSHIHISA
ITO YASU
IKEDA YASUNARI

(54) DATA TRANSMITTER AND DATA TRANSMISSION METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To improve more the quality of an OFDM modulation signal.
SOLUTION: A signal point transmitter 14 allocates a signal point Zkl in a QPSK modulation circuit 18 to parallel data S100 inputted from an S/P conversion circuit 100 by changing an amplitude so as to compensate an aperture effect of a communication transmission line and each section after an IFFT circuit 104 onto a modulation signal S20. D/A converter circuits 10611062 and LPF circuits 10811082 convert complex number data zkm into analog form and eliminate an undesired harmonic component to generate transmission signals S1061S1062. The QPSK modulation circuit 18 adopts the QPSK modulation system to generate a modulation signal S18 at an intermediate frequency band. A transmission circuit 20 converts the modulation signal S18 into a modulation signal S20 at a carrier frequency band of a communication transmission line to send it.

CLAIMS

[Claim(s)]
[Claim 1]It is data transmission equipment of an OFDM system characterized by comprising the followingData transmission equipment which assigns said each of two or more transmission data at a signal point of said prescribed quadrature

modulation method with which said signal point quota means gave an amplitude characteristic which compensates an aperture effect which said frequency domain and segment-of-time conversion method or subsequent ones give beforehand to said transmission signal.
A signal point quota means which assigns two or more transmission data of each which is the targets of transmission at a predetermined signal point of a prescribed quadrature modulation method.
A frequency domain and a segment-of-time conversion method which changes into a segment of time every 1 set of two or more of said transmission data assigned at a signal pointrespectively from a frequency domain
A D / A conversion means to change into analog format said two or more transmission data of a digital format changed into a segment of timeand to generate a transmission signal.
An orthogonal modulation means which modulates a carrier signal of predetermined frequency with said generated transmission signaland is sent out to a predetermined communication transmission line with said prescribed quadrature modulation method.

[Claim 2]Said signal quota means matches and memorizes complex type-type [showing a signal point of said prescribed quadrature modulation method assigned to a bit string of two or more of said transmission dataand said each of bit string of two or more of said transmission data] signal point dataThe data transmission equipment according to claim 1 which outputs said signal point data according to said each of bit string of two or more of said transmission data inputted.
[Claim 3]A counting circuit which said signal quota means calculates the number of said bit strings of two or more of said transmission data inputtedand supplies these enumerated data to said signal point memory measureA reset circuit which resets enumerated data of said counting circuit whenever said bit string of 1 set of two or more of said transmission data is inputtedSaid bit string of two or more of said transmission data and enumerated data of said counting means are used as address input dataThe data transmission equipment according to claim 2 which has a memory circuit which memorizes said each of signal point data to a memory address which said each of address input data showsand outputs said signal point data according to said address input data.
[Claim 4]By two or more transmission data which was assigned at a signal point of said prescribed quadrature modulation methodwas changed into a segment of time from a frequency domainand was changed into analog format. It is a data transmission method of an OFDM system which becomes irregular with a prescribed quadrature modulation methodand transmits two or more carrier signals of each of predetermined frequencyA data transmission method which assigns said each of two or more transmission data at a signal point of said prescribed quadrature modulation method which gave a predetermined amplitude characteristic beforehand so that an aperture effect given to said each of two or more transmission data in the case of said modulation process and transmission

may be compensated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention compensates the aperture effect given to a transmission signal inside data transmission equipmentand relates to the data transmission equipment and the data transmission method which improved the transmission characteristic.
[0002]
[Description of the Prior Art]From the formeras a modulating method at the time of transmitting digital data. For examplethe PSK (Phase Shift Keying) method to which the phase of a single carrier signal is changed according to the value of dataAnd quadrature modulation methodssuch as a QAM (Quadrature Amplitude Modulation) method which becomes irregular by changing the phase and amplitude of a carrier signal according to the value of dataare used well.
[0003]The orthogonal frequency division multiplex method (OFDM system; Orthgonal Frequency Division Multiplexing) is proposed as a new modulating method at the time of transmitting digital data these days. This OFDM system modulates two or more carrier signals of each included in transmission frequency bandwidth by two or more data of each of a comparatively low data rategenerates two or more modulating signalsand is [modulating signals] parallel and transmits these modulating signals.
[0004]In an OFDM systemsince transmission frequency bandwidth is divided into two or more carrier-signal correspondences and usedthe transmission band of per one modulating signal (carrier signal) becomes narrowand the transmission data rate per modulating signal cannot be made high compared with a QAM method etc. Howeversince it can be parallel and two or more modulating signals can be transmittedthe OFDM system can make the transmission data rate of the whole transmission frequency bandwidth equivalent to a QAM method etc.
[0005]Since the transmission data rate of an OFDM system per modulating signal is lowthe tolerance over a multipass ghost obstacle is highand it is suitable for the data communications through the wireless communications lines using a terrestrial wave.
For exampleit is observed as a transmission system for new digital television broadcast.
An OFDM system provides a television broadcasting office for two or more broadcasting areas of everyThese television broadcasting offices perform data distribution of digital television broadcast to each broadcasting areas using the radio wave signal of the same frequencyIt is observed also as a transmission system which can realize the SFN (Single Frequency Network) method which can use frequency resources effectively.

[0006]Although it is preferred for the modulation process and recovery processing in an OFDM system for fast Fourier transform processing and the fast Fourier inverse transformation processing to be applied and put in blockand to perform themrespectivelyConventionallyrealization of the device which can perform the Fourier conversion process and a Fourier reverse conversion process at high speed was difficultand the OFDM system was not necessarily practical. Howeverrealization became possible in hardware at high speed about the Fourier conversion process and the Fourier reverse conversion process with improvement in digital-signal-processing art in recent years. That isa majority of carrier signals [each of] are put in block by a majority of transmission data [each of]and it becomes irregularand much transmission data can be collectively recovered now from a majority of modulating signals [each of]and practicality of an OFDM system is increasing further.
[0007]When generating the transmission signal of an OFDM systemThe circuit which needs to carry out the digital to analog of the transmission data which carried out fast Fourier inverse transformationand performs this digital to analog processing usually has a predetermined frequency characteristicand an aperture effect will be given to the transmission signal to generate. Thusif the transmission signal with which the aperture effect was given digital to analog processing or on the communication transmission line is sent out to a communication linethe fault of an error rate increasing to the transmission data reproduced will arise.
[0008]Thereforeafter compensating the aperture effect given to a transmission signalit is necessary to carry out a transmission signal to a communication line. In order to compensate an aperture effectthe method of equalizing the transmission signal after changing into analog format conventionally through the filter which has a predetermined frequency characteristic etc. was taken. Howeverif a transmission signal is equalized and an aperture signal is equalized with a filter etc.the circuit structure of the circuit for performing equalization processing will become largethe miniaturization of transmission equipment and low cost-ization will be barredand also an aperture effect was not necessarily able to be compensated fully.
[0009]This invention is made in view of the problem of the conventional technology mentioned aboveand an object of this invention is to provide the data transmission equipment and the data transmission method which can raise more the quality of the modulating signal generated by an OFDM system. An object of this invention is to provide the data transmission equipment and data transmission equipment to which the data error rate of the transmission data reproduced from the modulating signal which passed through the communication line can be reduced.
[0010]An object of this invention is to provide the data transmission equipment and the data transmission method with which the aperture effect given to a modulating signal can fully be compensatedwhen generating the transmission signal of an OFDM system. An object of this invention is to provide the data transmission equipment and the data transmission method which can generate the modulating signal of the quality OFDM system with which the aperture effect was

fully compensated with a device [that it is small and low cost].
[0011]
[Means for Solving the Problem]To achieve the above objectsdata transmission equipment concerning this inventionA signal point quota means which assigns two or more transmission data of each which is the targets of transmission at a predetermined signal point of a prescribed quadrature modulation methodA frequency domain and a segment-of-time conversion method which changes into a segment of time every 1 set of two or more of said transmission data assigned at a signal pointrespectively from a frequency domainWith a D / A conversion means to change into analog format said two or more transmission data of a digital format changed into a segment of timeand to generate a transmission signaland said prescribed quadrature modulation method. It is data transmission equipment of an OFDM system which has an orthogonal modulation means which modulates a carrier signal of predetermined frequency with said generated transmission signaland is sent out to a predetermined communication transmission lineSaid signal point quota means assigns said each of two or more transmission data beforehand at a signal point of said prescribed quadrature modulation method which gave an amplitude characteristic which compensates an aperture effect which said frequency domain and segment-of-time conversion method or subsequent ones give to said transmission signal.
[0012]Suitably said signal quota means A bit string of two or more of said transmission dataComplex type-type [showing a signal point of said prescribed quadrature modulation method assigned to said each of bit string of two or more of said transmission data] signal point data is matchedit memorizes and said signal point data is outputted according to said each of bit string of two or more of said transmission data inputted.
[0013]A counting circuit which said signal quota means calculates the number of said bit strings of two or more of said transmission data inputtedand supplies these enumerated data to said signal point memory measure suitablyA reset circuit which resets enumerated data of said counting circuit whenever said bit string of 1 set of two or more of said transmission data is inputtedSaid bit string of two or more of said transmission data and enumerated data of said counting means are used as address input datasaid each of signal point data is memorized to a memory address which said each of address input data showsand it has a memory circuit which outputs said signal point data according to said address input data.
[0014]Data transmission equipment concerning this invention transmits N transmission data (N is an integer) which divided a sound and picture image data for television broadcasting into N piecesfor example with an OFDM system. In data transmission equipment concerning this inventiona frequency domain and a segment-of-time conversion methodThe fast Fourier inverse transformation (IFFT) processing of the signal point of quadrature modulation methodssuch as an PSK method which a signal point quota means assigned to 1 set (N pieces) of transmission dataand a QAM methodis carried outand it changes into a segment of

time from a frequency domainit bundles up about all the carrier signals used for transmissionand a modulation process is performed.
[0015]A D / A conversion means changes into analog format transmission data of a digital format changed into a segment of timeand generates a transmission signal. A D / A conversion means has a predetermined frequency characteristicand an aperture effect is given to a generated transmission signal. A carrier signal of an intermediate frequency band is modulated with a transmission signal which generated an orthogonal modulation means with the above-mentioned quadrature modulation methodand when still more nearly requiredfrequency conversion is carried out to carrier frequency of a communication transmission lineand it sends out to a communication transmission line.
[0016]After an aperture effect is given to a transmission signal by a D / A conversion meansa signal point quota means so that the amplitude characteristic of a transmission signal may carry out flattening into all the transmission frequency bandwidthIt assigns at a signal point which has beforehand the amplitude difference which negates an aperture effect for each N transmission dataand equalization processing of a transmission signal is made unnecessary. When an aperture effect given to a modulating signal by each component partcommunication transmission linesetc.such as an orthogonal modulation means after a D / A conversion meansis known beforehanda signal point quota meansIt assigns at a signal point so that an aperture effect given to a modulating signal by these may be compensated.
[0017]They are two or more transmission data which assigned a data transmission method concerning this invention at a signal point of said prescribed quadrature modulation methodwas changed into a segment of time from a frequency domainand was changed into analog formatIt is a data transmission method of an OFDM system which becomes irregular with a prescribed quadrature modulation methodand transmits two or more carrier signals of each of predetermined frequencySaid each of two or more transmission data is assigned at a signal point of said prescribed quadrature modulation method which gave a predetermined amplitude characteristic beforehand so that an aperture effect given to said each of two or more transmission data in the case of said abnormal conditions and transmission may be compensated.
[0018]
[Embodiment of the Invention]
A 1st less than embodiment and a 1st embodiment of this invention are described. Drawing 1 is a figure showing the composition of the data transmission equipment 1 of the QPSK(Quadrature Phase Shift Keying)-OFDM system concerning this invention in a 1st embodiment. As shown in drawing 1the data transmission equipment 1The serial/parallel-conversion circuit (S/P conversion circuit) 100the discrete Fourier inversion circuit (IFFT circuit) 104 of 102 or N points of signal point sending devices (MOD)digital to analog circuit (D/A conversion circuit) $106_1$$106_2$It comprises lowpass filter circuit (LPF circuit) $108_1$$108_2$the QPSK modulation circuit 18the sending circuit 20and the antenna 126.

[0019]The QPSK modulation circuit 18 comprises analog multiplying circuit $110_1$$110_2$the pi/2 phase-shifting circuit 112the local oscillation circuit (IFLOSC) 114 for intermediate frequenciesthe analog adder circuit 116and the band pass filter circuit 118 for intermediate frequencies (BPF circuit). The sending circuit 20 comprises the analog multiplying circuit 120the local oscillation circuit (RFLOSC) 122 for transmission frequency bandwidthand the BPF circuit 124 for transmission frequency.

[0020]For examplewhen using the data transmission equipment 1 for transmission of the sound and picture image data of digital television broadcast using a terrestrial wavethe sound and picture image data by which compression encoding was carried out with the MPEG system are serially inputted into the data transmission equipment 1 as the input data IN. The data transmission equipment 1 deals with the input data IN as one-piece N 2-bit data corresponding to the signal point of a QPSK modulation methodand generates and transmits the modulating signal of the OFDM system which has N carrier signals in transmission frequency bandwidth.

[0021]N transmission data $IN_{k \text{ contained in the input data IN into which the S/P conversion circuit 100 was inputtedand } l}$ -- each is changed into the data of 2 bit parallel formsand is outputted to the signal point sending device 102 as the parallel data S100. Drawing 2 is a figure showing correspondence with the value of transmission data $IN_{k \text{ and } l}$and the signal point of the QPSK modulation method which the signal point sending device 102 shown in drawing 1 assigns. Corresponding to the value of inputted transmission data $IN_{k \text{ of 2 bit parallel formsand } l}$ (l= 01--N-1)the signal point sending device 102 is assigned to signal point data $Z_{k \text{ of a QPSK modulation methodand } l}$as shown in drawing 2and it is outputted to IFFT circuit 104. Heresignal point data $Z_{k \text{ and } l}$ can be expressed like a lower type.

[0022]

[Equation 1]As for an integer and kthe real component of signal point data $Z_{k \text{ and } l}$$Y_{kand\ l}$ of the number of sequences of an OFDM symbol$X_{kand\ l}$ are [$Z_{kl}=X_{kl}+jY_{kl}$ however k and l] the imaginary components of signal point data $Z_{k \text{ and } l}$.

[0023]In the data transmission equipment 1as shown in a lower typethe absolute value of signal point data $Z_{k \text{ and } l}$ is constant.

[0024]

[Equation 2]| It is $Z_{k \text{ and } l}$|=Consthowever Const>0.

[0025]IFFT circuit 104 carries out IFFT processing of 1 set of N piece data [signal point] $Z_{k \text{ inputted from the signal point sending device 102and the } l}$ ($Z_{k0}Z_{k1}$--Z_{kN-1})N piece 1 set of complex data $z_{k \text{ and } m}$ ($z_{k0}z_{k1}$--z_{kN-1}) are generated. Howeverthe complex data which IFFT circuit 104 outputs is expressed with a lower type.

[0026]

[Equation 3]The real component of complex data $z_{k \text{ and } l}$$y_{kand\ l}$ of $z_{kl}=x_{km}+jy_{km}$ however $x_{kand\ l}$ are the imaginary components of complex data $z_{k \text{ and } l}$.

[0027]D/A conversion circuit 106_1 and 106_2Complex data $z_{k \text{ of a digital format inputted from IFFT circuit 104respectivelyreal component xk of mm}}$ and imaginary component $y_{kand\ m}$ are changed into analog formatIt outputs to LPF circuit 108_1 and 108_2 as transmission signal $S106_1$

and $S106_2$. LPF circuit 108_1 and 108_2 remove unnecessary harmonic content of D/A conversion circuit 106_1transmission signal $S106_1$ inputted from $106_2$and $S106_2$respectivelyIt outputs to multiplication circuit 110_1 of the QPSK modulation circuit 18and 110_2 as transmission signal $S108_1$ and $S108_2$.

[0028]In the QPSK modulation circuit 18the local oscillation circuit 114 generates a carrier signal of an intermediate frequency bandand outputs it to the multiplication circuit 110_1 and pi/2 phase-shifting circuit 112. a phase of a carrier signal into which the pi/2 phase-shifting circuit 112 was inputted from the local oscillation circuit 114 -- pi/2rad (90 degrees) -- it is delayedand a phase shift is carried outand it multiplication circuit 110_2 receives and outputs. Transmission signal $S108_1$ into which multiplication circuit 110_1 and 110_2 were inputted from LPF circuit 108_1 and 108_2respectivelyand $S108_2$a carrier signal inputted from the local oscillation circuit 114and the local oscillation circuit 114 -- pi/2rad -- the multiplication of the carrier signal by which the phase shift was carried out is carried out in analogand it outputs to the adder circuit 116 as multiplication signal $S110_1$ and $S110_2$.

[0029]The adder circuit 116 adds multiplication circuit 110_1multiplication signal $S110_1$ inputted from $110_2$and $S110_2$and outputs them to the BPF circuit 118 as the modulating signal S116. The BPF circuit 118 removes unwanted signal components other than an intermediate frequency band from the modulating signal S116 inputted from the adder circuit 116. The QPSK modulation circuit 18 modulates a carrier signal of an intermediate frequency band by a QPSK modulation method by such component partgenerates the modulating signal S18and outputs it to the multiplication circuit 120 of the sending circuit 20.

[0030]In the sending circuit 20the local oscillation circuit 122 generates a carrier signal of frequency which suited a communication transmission lineand outputs it to the multiplication circuit 120. The multiplication circuit 120 carries out the multiplication of a carrier signal inputted from the local oscillation circuit 122and the modulating signal S18 inputted from the QPSK modulation circuit 18 in analoggenerates the modulating signal S120 of transmission frequency bandwidthand outputs it to the BPF circuit 124.

[0031]The BPF circuit 124 removes unwanted signal components other than transmission frequency bandwidth from the modulating signal S120 inputted from the multiplication circuit 120. By such component partthe sending circuit 20 changes the modulating signal S18 of an intermediate frequency band into the modulating signal S20 of a carrier frequency zoneand sends it out to a communication transmission line via the antenna 126.

[0032]As explained abovethe data transmission equipments 1 are N transmission data IN_k which constitutes the input data INsuch as a soundpicture image dataetc. of television broadcasting which carried out compression encodingand $_1$N carrier signals in transmission frequency bandwidth are modulatedthe modulating signal S20 of an OFDM system is generatedand it distributes to a receiving set of an audience's house.

[0033]Since according to the data transmission equipment 1 concerning this invention transmission data can be transmitted with a transmission data rate

equivalent to a case where modulation methodssuch as a QAM methodare used and also a transmission data rate per modulating signal can be made lowit is hard to be influenced by a multipass ghost obstacle etc. Thereforethe data transmission equipment 1 is suitable for digital television broadcast which used a terrestrial wave. Since the data transmission equipment 1 performs data communications with an OFDM systemit fits transmission of a SFN method and can exploit frequency resources effectively.

[0034]Although a QPSK method was used for the data transmission equipment 1 in the 1st example as a modulation method in the QPSK modulation circuit 18For exampleby changing the S/P conversion circuit 100 so that 4-bit parallel data may be generatedand changing the signal point sending device 102 so that a signal point of a 16QAM method may be assignedIn the QPSK modulation circuit 18other multiple-value quadrature modulation methodssuch as a 16QAM methodcan also be usedandas for two or more modulation methods and a metaphorit is still more possible in the QPSK modulation circuit 18 to also make a QAM method and an PSK method intermingled.

[0035]Each component part of the data transmission equipment 1 does not ask whether an equivalent function and performance are realized in hardware only in the inside which can be collateralizedor it realizes by software. The data transmission equipment 1 can be used for a use which transmitsother kindsfor exampledata for computersbesides [which transmits a sound and picture image data of a television program] a use.

[0036]A data transmission method in the data transmission equipment 1 is applicable to record of a magnetic recording medium only not only in data transmission equipmentfor example. The data transmission equipment 1 can be used for data communications not only through data communications through a radio transmission line but a wire communication transmission line.

[0037]A 2nd less than embodiment and a 2nd embodiment of this invention are described. Drawing 3 is a figure showing composition of the data transmission equipment 2 of a QPSK-OFDM system concerning this invention in a 2nd embodiment. As shown in drawing 3the data transmission equipment 2 comprises the S/P conversion circuit 100the signal point sending device 14IFFT circuit 16D/A conversion circuit $106_1$$106_2$LPF circuit $108_1$$108_2$the QPSK modulation circuit 18the sending circuit 20and the antenna 126. Same component part and a signal (data) of the data transmission equipment 2 as the data transmission equipment 1 shown in drawing 1 attach the same numeralsand are shown.

[0038]Drawing 4 is a figure showing composition of the signal point sending device 14 shown in drawing 3. As shown in drawing 4the signal point sending device 14 comprises ROM142 and the subcarrier counter circuit 144. The subcarrier counter circuit 144 counts up enumerated datawhenever the parallel data S100 are inputted into the signal point sending device 14. That isthe signal point sending device 14 calculates the subscript I of transmission data $INZ_{k\ and\ I}$ (I= 01--N-1)and receives ROM142 in the enumerated data S144 (01--N-1;ROM#0 - ROM#N-1 (drawing 5))For exampleit outputs as a high order bit of an address of ROM142and

a ROM table (ROM#0 - ROM#N-1) in the modulating signal S20 memorized by ROM142 for every subcarrier is switched. Enumerated data of the subcarrier counter circuit 144 are reset by the reset signal S16c inputted from IFFT circuit 16and are set to 0.

[0039]As a high order bit of an address of ROM142The enumerated data S144 of the subcarrier counter circuit 144 are inputted as mentioned abovefor examplethe parallel data S100 inputted from the S/P conversion circuit 100 and the enumerated data S144 of the subcarrier counter circuit 144 are inputted as a lower bit.

[0040]Drawing 5 is a figure showing the contents of signal point data $Z_{k \text{ memorized to an address of ROM142 shown in drawing 4and I}}$. An amplitude characteristic (aperture effect) of signal point data $Z_{k \text{ and } I}$ which each portion and communication transmission linessuch as D/A conversion circuit 106_1 after IFFT circuit 16 and 106_2give to the modulating signal S20 is sinc. A case where it is expressed with [kpi/2N] is shown.

[0041]In each address of ROM142as shown in drawing 5signal point data $Z_{k \text{ and } I}$ are memorized in the form of a complex number as a ROM table (ROM#0 - ROM#N-1) for every N carrier signals of the modulating signal S20. Herealso in the data transmission equipment 2signal point data $Z_{k \text{ and } I}$ can be expressed like a lower type like a case of the data transmission equipment 1 (drawing 1).

[0042]

[Equation 4]As for an integer and kthe real component of signal point data $Z_{k \text{ and } I}$ $Y_{k \text{and } I}$ of the number of sequences of an OFDM symbol$X_{k \text{and } I}$ are [$Z_{kI}=X_{kI}+jY_{kI}$ however k and I] the imaginary components of signal point data $Z_{k \text{ and } I}$.

[0043]The absolute value of signal point data $Z_{k \text{ memorized by ROM142 and } I}$According to the enumerated data S144 of the subcarrier counter circuit 144and the value of the parallel data S100 inputted from the S/P conversion circuit 100The predetermined frequency characteristic is added so that each component part after IFFT circuit 16 and the aperture effect especially given to the modulating signal S20 with D/A conversion circuit $106_1$$106_2$or the frequency characteristic of a communication transmission line measured beforehand may be compensated. As the data transmission equipment 2 is shown in a lower type unlike the data transmission equipment 1 (drawing 1)the absolute value (amplitudeaverage power) of signal point data $Z_{k \text{ and } I}$ is not constant.

[0044]

[Equation 5]$|Z_{kI}|=f$ (S144S100)

Howeverf(S144S100) > 0 and f (S144S100) are the amplitude of a signal point which becomes settled according to the parallel data S100 and the enumerated data S144.

[0045]IFFT circuit 16 like IFFT circuit 104 of the data transmission equipment 1 (drawing 1)IFFT processing of 1 set of N piece data [signal point] $Z_{k \text{ outputted from the signal point sending device 102 and the } I}$ ($Z_{k0}Z_{k1}$--Z_{kN-1}) is carried outand N piece 1 set of complex data $z_{k \text{ and } m}$ ($z_{k0}z_{k1}$--z_{kN-1}) are generated.

[0046]IFFT circuit 16 activates the reset signal S16cwhenever N signal point data (1 set) $Z_{k \text{ and } I}$ are inputted from the signal point sending device 14and it clears the

enumerated data S144 of the subcarrier counter circuit 144 of the signal point sending device 14 zero times. Complex data which IFFT circuit 16 outputs is expressed with a lower type like IFFT circuit 104 of the data transmission equipment 1 (drawing 1).

[0047]

[Equation 6]The real component of complex data $z_{k \text{ and } l}$ $y_{k \text{and } l}$ of $z_{kl}=x_{km}+jy_{km}$ however $x_{k \text{and } l}$ are the imaginary components of complex data $z_{k \text{ and } l}$.

[0048]Hereafteroperation of the data transmission equipment 2 is explained. N transmission data $IN_{k \text{ into which the S/P conversion circuit 100 was inputted in serial form and } l}$ -- each is changed into the parallel data S100 of 2 bit parallel forms. In the signal point sending device 14the subcarrier counter circuit 144 outputs the enumerated data S144 which show the number of the inputted parallel data S100 as a high order bit of the address of ROM142and chooses the ROM table (ROM#0 - ROM#N-1) memorized by ROM142.

[0049]The value of the parallel data S100 is inputted into the lower bit of ROM142and ROM142 outputs signal point data $Z_{k \text{ according to the enumerated data S144 and the parallel data S100 of ROM142 which were shown in drawing 5 and } l}$ to it to IFFT circuit 16. IFFT circuit 16 carries out IFFT processing of 1 set of N piece data [signal point] $Z_{k \text{ inputted from the signal point sending device 14and the } l}$ ($Z_{k0}Z_{k1}$--Z_{kN-1})N piece 1 set of complex data $z_{k \text{ and } m}$ ($z_{k0}z_{k1}$--z_{kN-1}) are generatedand it outputs to D/A conversion circuit 106_1 and 106_2.

[0050]D/A conversion circuit 106_1106_2 and LPF circuit $108_1$and 108_2Complex data $z_{k \text{real component xk [of m]m}}$and imaginary component $y_{k \text{ and } m}$ are changed into analog formatrespectivelyunnecessary harmonic content is removedtransmission signal $S106_1$ and $S106_2$ are generatedand it outputs to the QPSK modulation circuit 18.

[0051]With a QPSK modulation methodthe QPSK modulation circuit 18 modulates a carrier signal of an intermediate frequency band by transmission signal $S106_1$ and $S106_2$generates the modulating signal S18and outputs it to the sending circuit 20. The sending circuit 20 changes the modulating signal S18 into the modulating signal S20 of a carrier frequency zoneand sends it out to a communication transmission line via the antenna 126.

[0052]As stated abovethe data transmission equipment 2 so that an aperture effect beforehand given to the modulating signal S20 by D/A conversion circuit 106_1106_2or communication transmission line with the signal point sending device 16 may be compensatedSince input data $IN_{k \text{signal point data Zk which changed amplitude according to } l \text{ (parallel data S100) and } l}$ are assignedflattening of the amplitude characteristic of the modulating signal S20 can be carried out in all the transmission frequency bandwidthwithout using a filter for equalizationetc. Thereforean error rate of input data $IN_{k \text{ reproduced and } l}$ can be reduced.

[0053]Since the filter for equalization for equalizing the modulating signal S20 is unnecessarythe data transmission equipment 2 has small circuit structureand is low cost. Since the data transmission equipment 2 can assign signal point data $Z_{k \text{ optimized beforehand and } l}$ to input data $IN_{k \text{ and } l}$ (parallel data S100)it can compensate them for sufficient aperture effect to the modulating signal S20. The change same to the data transmission equipment 1 (drawing 1) shown as a 1st embodiment also to

the data transmission equipment 2 shown as a 2nd embodiment is possible.

[0054]

[Effect of the Invention]According to the data transmission equipment and the data transmission method which start this invention as stated abovethe quality of the modulating signal generated by an OFDM system can be raised more. According to the data transmission equipment and the data transmission method concerning this inventionthe data error rate of the transmission data reproduced from the modulating signal which passed through the communication line can be reduced.

[0055]According to the data transmission equipment and the data transmission method concerning this inventionwhen generating the modulating signal of an OFDM systemthe aperture effect given to a modulating signal can fully be compensated. According to the data transmission equipment and the data transmission method concerning this inventionthe modulating signal of the quality OFDM system with which the aperture effect was fully compensated is generable with a device [that it is small and low cost].

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the composition of the data transmission equipment of the QPSK-OFDM system concerning this invention in a 1st embodiment.

[Drawing 2]It is a figure showing correspondence with the value of transmission data $IN_{k \text{ and } l}$ and the signal point of the QPSK modulation method which the signal point sending device shown in drawing 1 assigns.

[Drawing 3]It is a figure showing the composition of the data transmission equipment of the QPSK-OFDM system concerning this invention in a 2nd embodiment.

[Drawing 4]It is a figure showing the composition of the signal point sending device shown in drawing 3.

[Drawing 5]It is a figure showing the contents of signal point data $Z_{k \text{ memorized to the address of ROM shown in drawing 4 and } l}$.

[Description of Notations]

12 -- Data transmission equipment100 -- A S/P conversion circuit10214 -- Signal point sending device10416 -- An IFFT circuit106_1,106_2 -- D/A conversion circuit18 -- A QPSK modulation circuit108_1,108_2 -- LPF circuit110_1,110_2 [-- An adder circuit118 / -- A BPF circuit20 / -- A sending circuit120 / -- A multiplication circuit122 / -- A local oscillation circuit124 / -- A BPF circuit126 / -- Antenna] -- A multiplication circuit112 -- pi/2 phase-shifting circuit114 -- A local oscillation circuit116